Space Weather Technical Forecast

Issued on Friday, 08 September 2023 at 13:13 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

---

Space Weather Forecast Headline: Chance of M-flares (R1-R2 radio blackouts).

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Moderate in the past 24 hours with several C-class flares and one M-class flare from near to AR3425, peaking at M2.1 at 07/1909 UTC. There are currently six sunspot regions on the visible disc. The largest and most complex region is now AR3423. It consists of two relatively large spots aligned east-west with several smaller spots and rudimentary penumbra in-between, some waxing and waning. AR3421 is becoming less extensive and magnetically simpler, with most spots fading. AR3424 is also becoming smaller and simpler, with rudimentary penumbra. AR3425 is still developing but looks somewhat innocuous, most of its spots remaining relatively small. Its magnetic configuration is becoming a bit more complex though, which perhaps explains why this region was responsible for the largest observed flare. The other regions are relatively small and simple.

There have been multiple CMEs in the past 24 hours, none of which are considered to be Earth-directed. A filament lift-off was observed shortly after 07/1900UTC, originating from the vicinity of AR3425 simultaneously with the M2.1 flare. Another CME was observed on coronagraph imagery. The source is believed to be on or slightly behind the eastern horizon and does not pose a threat to Earth. Finally, a faint partial halo was observed in the early UTC afternoon of the 07th however, given the lack of clues on satellite imagery at that time, it is believed to have originated from the far side.

Solar Wind / Geomagnetic Activity: Solar wind parameters, as measured at L1, were indicative of a slow regime. Solar wind speeds were mostly around 340-350km/s, briefly increasing to 380km/s for a time in the UTC evening. Density was below average throughout. The IMF was weak and below 5nT throughout. The north-south component varied weakly between +/-4nT. The phi angle was mostly negative (towards the sun), but became positive (away from the sun) for a time during the UTC evening. Geomagnetic activity was Quiet (Kp 0-2), with only one Unsettled interval (08/0000-0300UTC).

Energetic Particles / Solar Radiation: GOES16 high energy (greater than 10MeV) proton flux has been at background levels throughout. GOES16 high energy (greater than 2MeV) electron flux was predominantly at background levels but became moderate for a time, peaking at 399 pfu at 07/1915 UTC. The associated 24-hour fluence was below the Active threshold on a declining trend, with 1.31e7 integrated pfu observed at 08/0000UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: There is a chance of M-class flares throughout the period, mostly from AR3423 and AR3425.

Solar Wind / Geomagnetic Activity: The CME that left the sun on the 05th may arrive at Earth late on Day 2 (09 Sep) with a chance of geomagnetic enhancements. However, it is worth noting

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2023. All Rights Reserved.

that its analysis was contaminated by other CMEs occurring in the background, thus reducing confidence. No other Earth-directed CMEs have been observed in the last 24 hours.

With an absence of significant coronal holes on the western hemisphere, the solar wind is most likely to remain slow-ambient, with no significant or long-lasting enhancement.

Geomagnetic activity is expected to be mostly Quiet to Unsettled, but with a risk of becoming Active with a slight chance of isolated G1/Minor Storm intervals late om Day 2 into Day 3, under the influence of the CME that left the sun on the 05th.

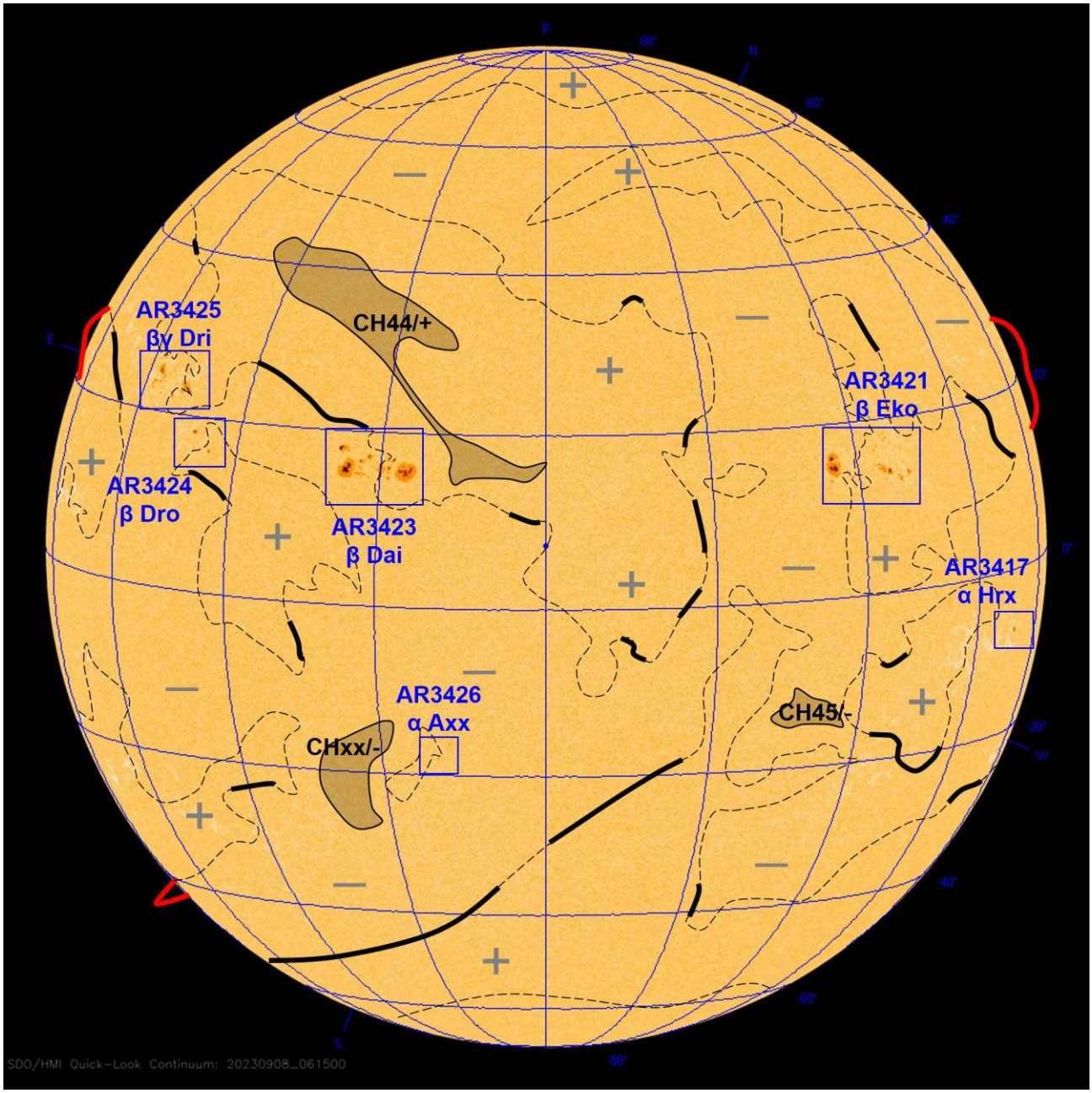
Energetic Particles / Solar Radiation: High energy (greater than 10 MeV) proton flux is expected to remain at background levels, with a very slight chance of an enhancement should any larger flares occur from AR3423 and AR3425, especially later in the period.

High energy (greater than 2 MeV) electron flux carries high uncertainty, however it is thought most likely that fluence will remain below the Active (1e8 integrated pfu) threshold throughout, with just a slight chance of reaching this level mainly later in the period.

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2023. All Rights Reserved.

Figure 1. Solar Analysis Valid 08/0800 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2023. All Rights Reserved.

Geomagnetic Storms:

The CME that was modelled to give Earth a glancing blow in the early UTC hours of the 08th has not occurred, meaning the ejecta has most likely passed behind Earth and is no longer expected to pose a threat. Another CME was modelled to have Earth-directed components. This CME, which left the sun on 05th, has been analysed as fairly slow and should arrive late on Day 2 (09 Sep) with a chance for some enhancement of geomagnetic activity. However, it is worth noting that its analysis was contaminated by other CMEs occurring in the background, thus reducing confidence. No other Earth-directed CMEs have been observed in the last 24 hours.

With an absence of significant coronal holes on the western hemisphere, the solar wind is most likely to remain slow-ambient. There may be sight enhancements from CH43/- (no longer visible on SDO imagery) and/or CH/45/- over the next three days but both are small, so much so that corresponding geomagnetic activity is most likely to be muted. The solar wind persistence model (SWPM) is considered to give good guidance in that respect.

In summary, in the absence of any further Earth-directed CMEs, geomagnetic activity is expected to be mostly Quiet to Unsettled, but with a risk of becoming Active with a slight chance of isolated G1/Minor Storm intervals late om Day 2 into Day 3, under the influence of the CME that left the sun on the 05th.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	1	10	10	5
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
06/0610	Partial	Plage	S-Centre disc	440 km/s	Late 09 Sep	Limited impact expected.

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2023. All Rights Reserved.

Figure 2: Solar Wind Persistence Model (SWPM), considered to provide good guidance (away from CME influences)

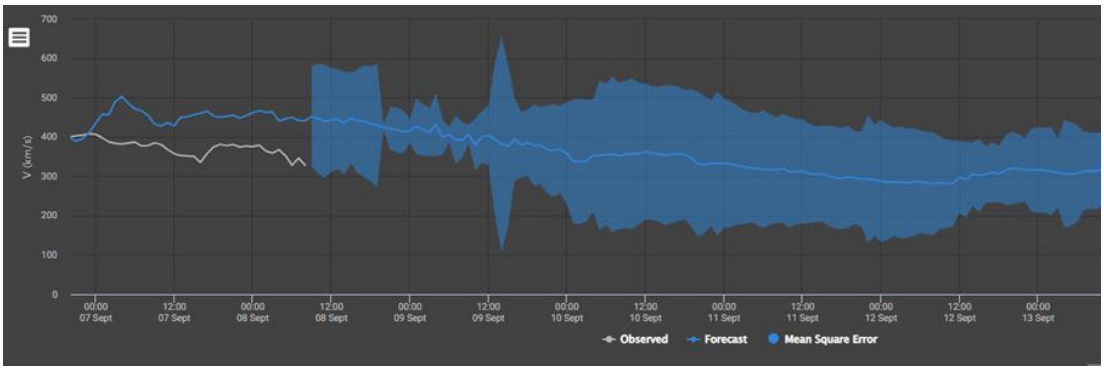
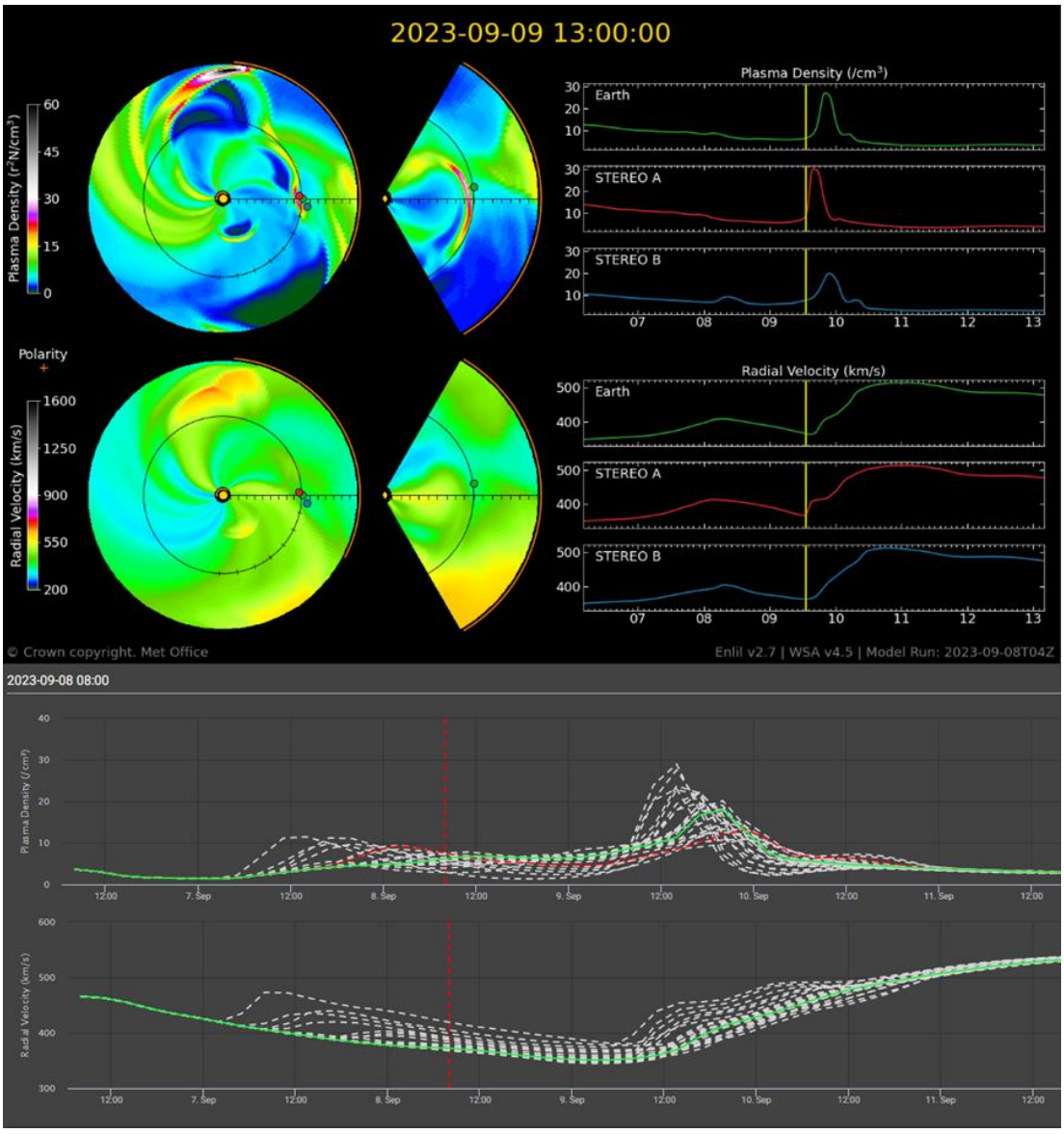


Figure 3: MOSWOC Enlil and ensemble, showing the arrival of a CME at Earth late on the 09th.



Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2023. All Rights Reserved.

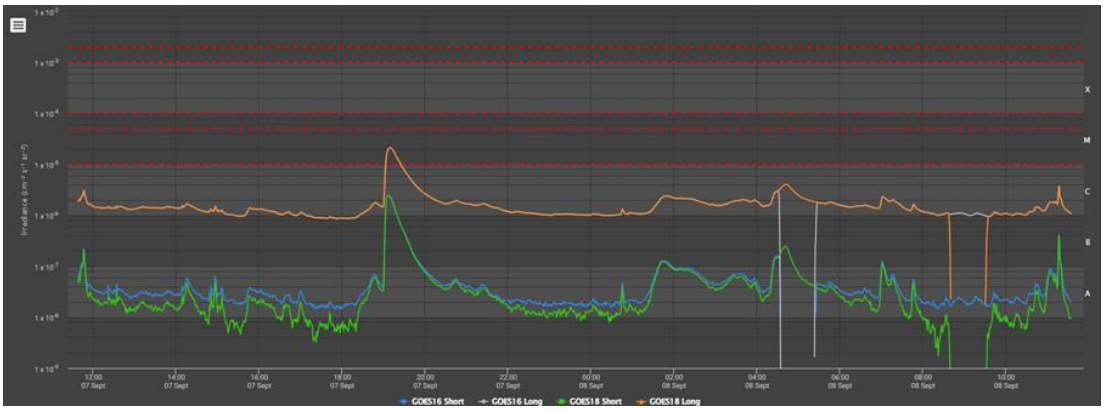
Radio Blackouts - X-Ray Flares:

There are currently six sunspot regions on the visible disc. The largest and most complex region is now AR3423. It consists of two relatively large spots aligned east-west with several smaller spots and rudimentary penumbra in-between, some waxing and waning. AR3421 is becoming less extensive and magnetically simpler, with most spots fading. AR3424 is also becoming smaller and simpler, with rudimentary penumbra. AR3425 is still developing but looks somewhat innocuous, most of its spots remaining relatively small. Its magnetic configuration is becoming a bit more complex though, which perhaps explains why this region was responsible for the largest observed flare, an M2.1 at 07/1909 UTC. The other regions are relatively small and simple.

There is a significant amount of filaments on the visible disc. These will need to be closely monitored for any lift-off. No significant regions are expected to depart the disc in the period. However, there are signs from far-side soundings as well as persistence that one or more new regions may rotate onto the disc in the coming days. The current growing trend from AR3423 and AR3425 mean that there is a continuing chance of M-flares throughout the period.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	40	40	40	40
Very Active	R3 to R5 X Class	No	5	5	5	5

Figure 4: Latest X-Ray Falre activity, as observed by GOES-16



Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

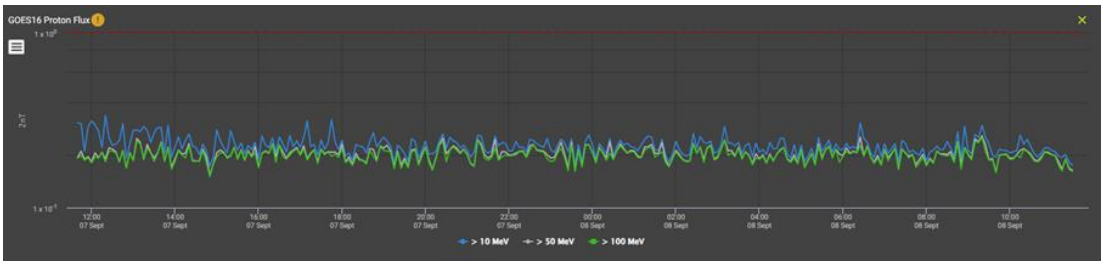
© Crown Copyright 2023. All Rights Reserved.

Solar Radiation Storms - (High Energy Protons):
The high energy (greater than 10MeV) proton flux observed by GOES16 is now at background levels.

Proton flux is most likely to remain at background levels, although there is a very slight chance of enhancements over the next few days, should any significant flares occur. The most likely contenders are currently AR3423 and AR3425, both in the northeast.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	5	5	10	10
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

Figure 5: Lest Protons Flux, as observed by GOES-16



Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

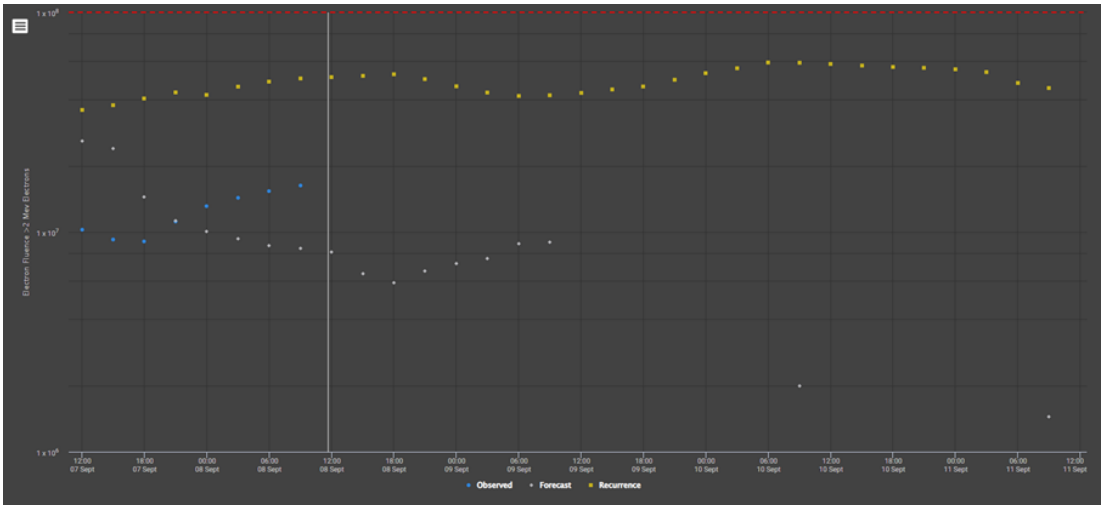
© Crown Copyright 2023. All Rights Reserved.

High Energy Electrons Event (≥ 2MeV):
High energy (greater than 2 MeV) electron flux is likely to remain at background to moderate levels for the start of this period, with further enhancements to the electron belt perhaps occurring through the coming days should fast winds arrive from CH43/- and CH45/-. An increase in flux and fluence levels is therefore possible towards the end of the period. However, there is also the potential for two CME arrivals which may suppress electron levels once again.

The associated 24-hour fluence will most likely remain below the Active (1e8 integrated pfu) threshold throughout the period, but with greatly decreasing confidence with time. MOSWOC REFM is considered to be giving good guidance initially, however, confidence falls through the period given the possible arrival of weak CMEs.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	10	20	20	20
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

Figure 6: Latest REFM output



Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2023. All Rights Reserved.